Comparative Study of PEB Industrial Structures Under Influence of Transverse Lateral Load Using STAAD Pro.

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Abstract*- Large Span, Column free structures are the most vital in any type of industrial structures and Pre Engineered Buildings (PEB) fulfills this requirement along with reducing time and cost as compared to conventional Steel Building (CSB). In the present work, Pre-Engineered Buildings (PEB) sections are designed as per Kirby technical specification which is based on ASCE-07. Later same structure to be analyzed for wind zone III to IS: 875 - 1987 (Part-I, Part-II, Part-III). A major portion of the analysis is carried out in Bentley STAAD-Pro V8i.Windward and leeward loading is applied to the transverse direction (Z direction).*

Keywords- Pre-Engineered Building, Wind load, STAAD-Pro V8i Software.

I. INTRODUCTION

A. General

Thus in pre-engineered buildings, the total design is done in the factory, and as per the design, members are pre-fabricated and then transported to the site where they are erected in a time less than 6 to 8 weeks. The structural performance of these buildings is well known and, for the most part, adequate code provisions are currently in place to ensure satisfactory behavior in high winds. Steel structures also have much better Strength-to-weight ratios than RCC and they also can be easily demolished. Pre Engineered Buildings have bolted connections and hence can also be reused after demolishing. Thus, pre-engineered buildings can be shifted or expanded as per the requirements in future

B. Classification of Steel Buildings

1) Conventional Steel Buildings

Conventional Steel buildings are consultant and conservative. The Structural members are hot rolled and are used in conventional buildings. The materials are produced or manufactured in the plant and are shifted to the site. The raw materials are processed in the site for the desired form and erected. The modifications can be done during erection by cut and weld process. Truss systems are used in conventional system.

2) Pre Engineered Steel Buildings

Pre Engineered Steel Buildings are manufactured or Produced in the plant itself. The manufacturing of structural members is done as per customer requirements. The detailed structural members are designed for their respective location and are numbered, which cannot be altered; because members are manufactured with respect to design features. These components are made in modular or completely knocked condition for transportation. These materials are transported to the customer site and are erected. Welding and cutting process are not performed at the customer site. No manufacturing process done at the customer site.

C. Applications of PEB

Applications of pre-engineered steel buildings include the following:

- Industrial Buildings & Workshops
- Warehouses
- Showrooms
- Corporate Office Buildings
- Schools

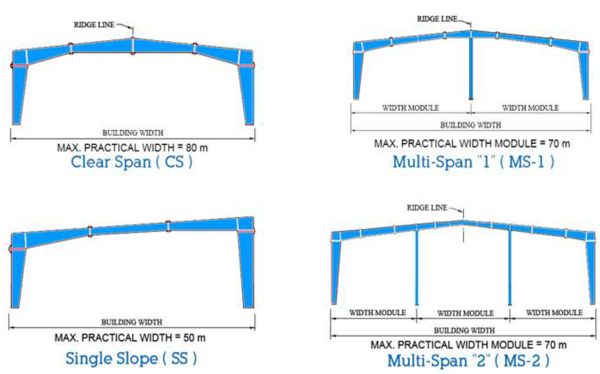

Figure I : Various types of PEB spans

D. Aim of PEB

1) Aim:-

The main aim is to study performance of pre-engineered building of an industrial shed for a wind load in various directions.

To study performance analysis of PEB for multi span (6 bays).

II. METHODOLOGY

A) Structural Analysis and Design:

STAAD Pro. Software may be utilized for analysing and designing practically for the Pre-Engineered Buildings. Implements the Axial Forces, Shear Forces, and Beam Stresses. Loads act like wind loads and accidental loads.

B) Plan of Project Work:

Study of PEB structure: To study the concept of PEB. Also compare deformation of Pre-engineered building (PEB) industrial structure with bracing or without bracing systems.

C) Plan of Analysis:

Modeling and Analysis: The four type of structure will be validating by modeling for transverse lateral load by using STAAD-Pro.

Comparison: The results obtained will be compared with that of other structures.

Expected Outcomes:

The output of this project:

- To understand various aspects related to design and modeling of the structure.
- Behavior of PEB building with bracing or without bracing system.

III. PROBLEM STATEMENT

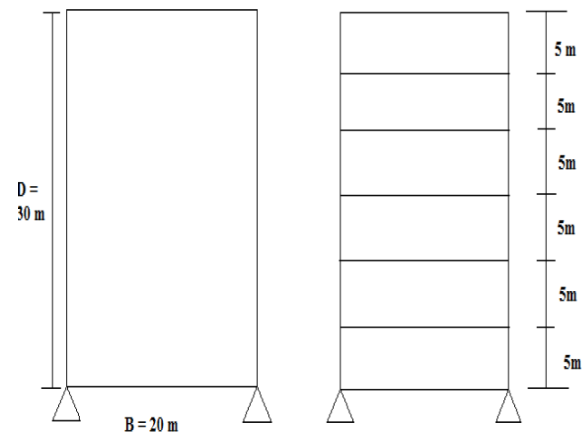

Figure II (a) -Frame structure in Y- Direction

Consider:-
Type I = PEB structure with Bracings @ X - direction.
Type II = PEB structure with single Bracings @ Z - direction.
Type III = PEB structure with cross Bracings @ Z - direction.
Type IV = PEB structure without Bracings.
Structure Having 20 m width and 30 m length, with 6 - bays c/c 5m

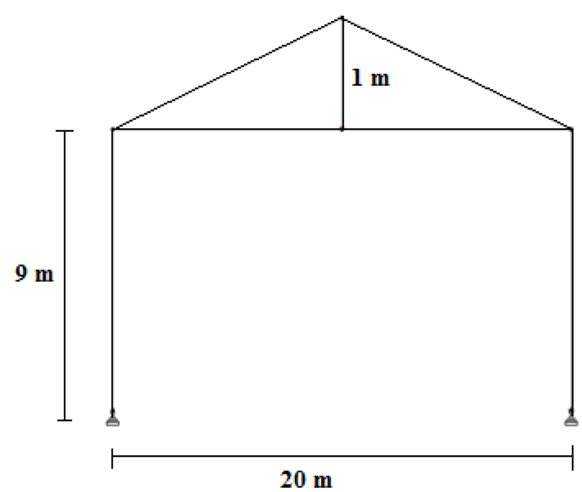

Figure II (b) - PEB Frame Structure in Z-Direction

Width of structure (B) = 20 m
Height of structure (h) = 9 m
Total Length of Structure (L) = 30 m
No. of Bays = 6 No. with c/c 5 m
Self-weight of purlin:- Assume section- 200 Z 1.5 having weight 4.07 Kg/m (From; ASCE-07)
Site location- Pune
Soil Type: - Medium Stiff.
Earthquake Zone: - Zone III
Assume: - Modulus of Elasticity (E) = 2.05 x 105 MPa

Step: -Wind Load Calculation:-

Take: - Basic Wind Speed (Vb) = 39 m/s
k2 (terrain height factor) as = 1.05
Design Wind Speed (Vz) = Vb × K2= 39 × 1.05
= 40.95 m/s
Design Wind Pressure (Pz) = 0.6 × ⟦Vz⟧^2
= 0.6 × ⟦(40.95)⟧^2
Pz = 1.006 KN/m^2
Assume:-Terrain Category (K2) from IS: 875(Part-III) [Clause 5.3.2.2]

Table I - Variation of Design wind speed and Pressure with height in different terrain

H (in m)	K_2	Vz (m/s)	Pz	Pz/1000 (KN/m^2)
0-5	1.0	39	912.6	0.9126
10	1.05	40.95	1006.14	1.0061
15	1.09	42.51	1084.26	1.0843
20	1.12	43.68	1144.76	1.1447

PEB structures with various Bracing Systems:-

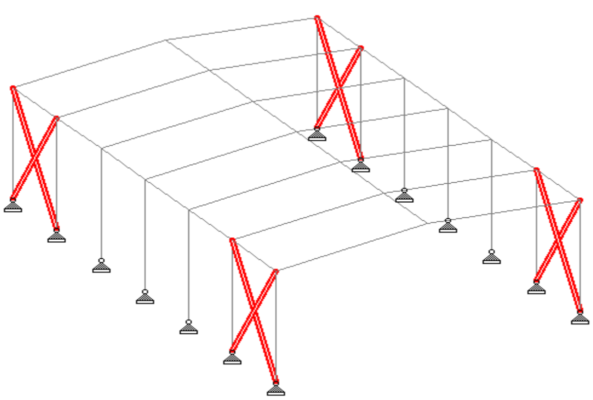

Figure IV- PEB structure with Bracings @ X – direction (Type-I)

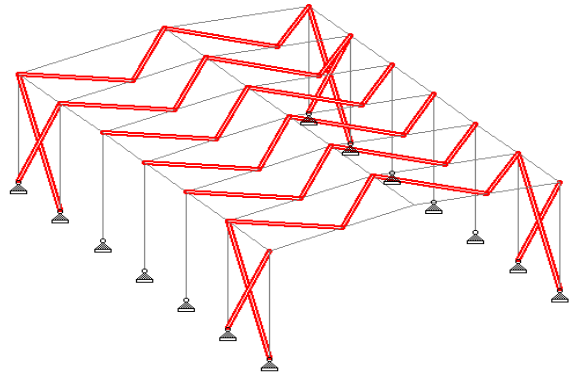

Figure V- PEB structure with Single Bracings @ Z – direction (Type-II)

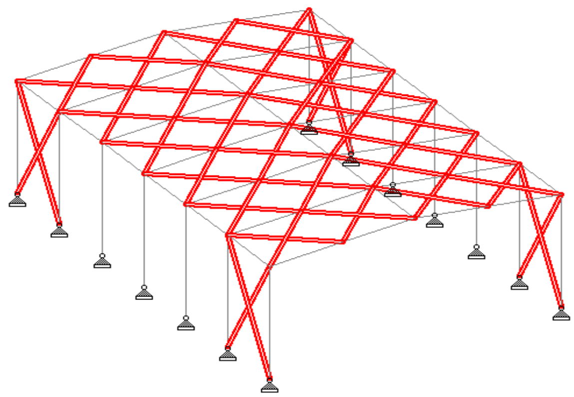

Figure VI- PEB structure with Cross Bracings @ Z – direction (Type III)

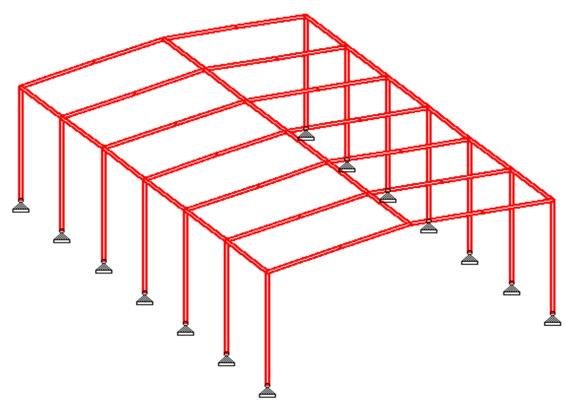

Figure VII - PEB structure without Bracings (Type IV)

V. RESULT AND DISCUSSION

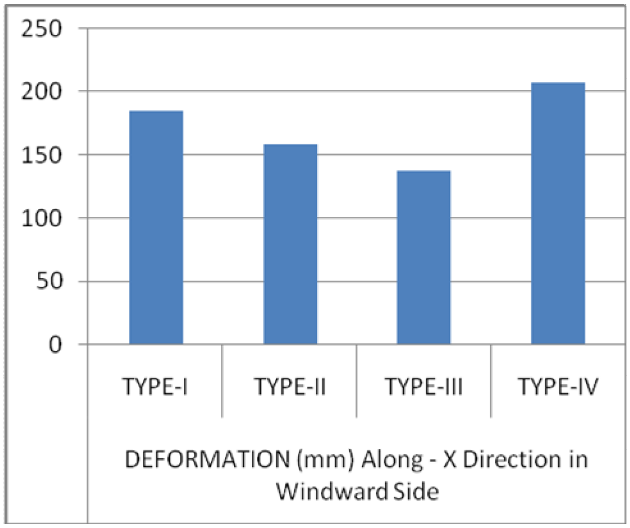

Figure VIII - Deformation @ Windward side in X direction.

The above figure shows comparison when wind load act at windward side of the structure in X-direction, the deformation in the structure without bracings (Type-IV) is maximum as compare to other.

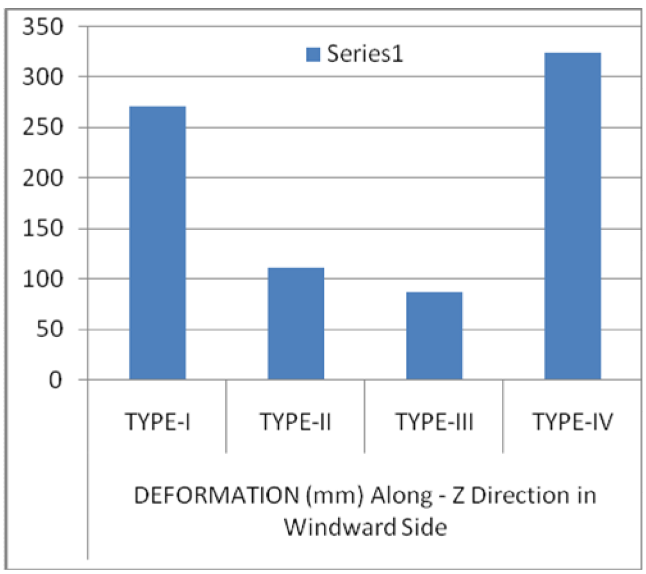

Figure IX - Deformation @ Windward side in X- direction.

The above figure shows that when loads acting at Windward side of the structure in Z-direction, the deformation in the structure provided with cross-bracings (Type-III) is minimum.

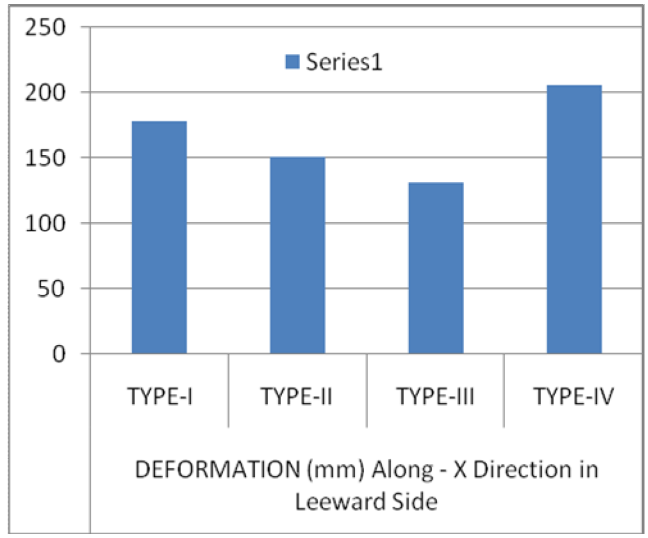

Figure X - Deformation @ Leeward side in X – direction

The Above Figure shows that lateral loads act at Leeward side of the structure in X-direction, then the deformation in the structure without bracing system(Type-IV) is maximumas same as that for windward side.

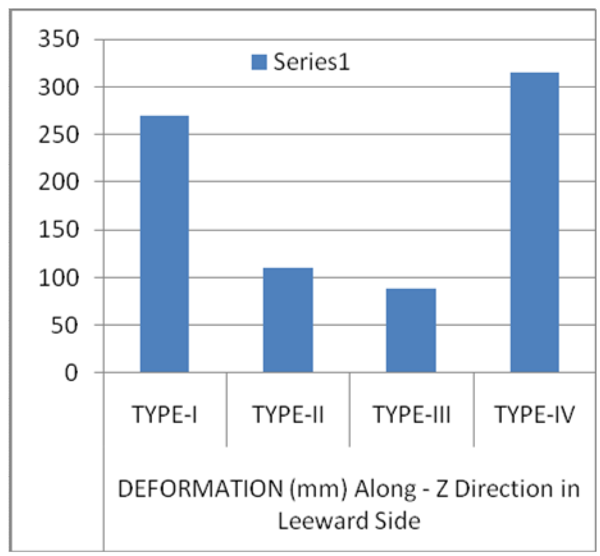

Figure XI - Deformation @ Leeward side in Z- direction

This figure shows that whenever load acting to the structure in Z-direction then the deformation in the structure provided with bracing is always minimum.

VI. CONCLUSION

In this paper PEB structures are analyzed subjected to transverse direction only. So far it was observed that wind analysis is performed along windward and leeward direction in longitudinal side. From parametric models following conclusions can be made.

In this paper we can conclude that when load is applied to the structure in the X- direction either in windward or in the Leeward side, the deformation of the structure provided without bracing system (Type-IV) is always maximum.

When lateral loads acting along windward side in X-direction the minimum deflection is occur in Type-III (structure with bracings) which is about 20-25% lesser than other models.

Same results are observed for Leeward side and also in Windward side of structure in Z- direction.

When load is applied to the structure in the Z-direction either in windward or in the Leeward side, the deformation of the structure providing without bracings (Type-IV) is always maximum.

From all this results we can conclude that when the structure is designed for lateral loading condition (Load acting at Z direction) the structure provided with bracing system is more suitable than structure without bracing (Simple PEB) system.

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